

AIR FORCE RESEARCH LABORATORY



Human Performance Modeling Presentation/Brief

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November 2005

Interim Report for October 1998 to November 2005

20060322013

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REPORT DOCUMENTATION PAGEForm Approved
OMB No. 0704-0188

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1. REPORT DATE (DD-MM-YYYY) November 2005		2. REPORT TYPE Interim		3. DATES COVERED (From - To) October 1998 - November 2005	
4. TITLE AND SUBTITLE Human Performance Modeling Presentation/Brief				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER 63231F	
6. AUTHOR(S) Michael J. Young				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER 49230400	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Materiel Command Air Force Research Laboratory Human Effectiveness Directorate Warfighter Interface Division Cognitive Systems Branch Wright-Patterson AFB OH 45433-7604				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) AFRL-HE-WP-TP-2006-0001	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited. Cleared by Public Affair, 3 Jan 06, #WS-05-2680.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS Crowd Modeling, Modeling, Simulation					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 38	19a. NAME OF RESPONSIBLE PERSON Michael J. Young
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			19b. TELEPHONE NUMBER (include area code) 937-255-8229

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

Human Performance Modeling



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Introduction



- **AFRL manages the Defense Modeling and Simulation Office (DMSO) Human Performance program**
- **Today I will provide an overview of:**
 - **Crowd modeling**
 - **Rules of engagement simulation**
 - **Non-lethal weapons modeling**
 - **Cultural modeling testbed**
 - **Recently transition projects**

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These are the topics I will be covering today:

Crowd modeling

Rules of engagement simulation

Non-lethal weapons modeling

Cultural modeling testbed

Recently transition projects



Crowd Federate



- Prime Contractor: Virginia Modeling, Analysis, and Simulation Center
- Project Definition
 - Develop and demonstrate a culturally variable crowd federate that can interoperate with existing military simulations
- Specific Technology
 - Crowd conceptual models
 - Crowd federate that interacts with JSAF and OneSAF
 - Behavioral moderators for crowds
- Users and Sponsors
 - Air Force Research Lab
 - Defense Modeling and Simulation Office
 - Joint Forces Command
 - Joint Non-Lethal Weapons Directorate
 - Army Maneuver Support Battlelab



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The Prime contractor is VMASC

The goal of the effort is to:

Develop and demonstrate a culturally variable crowd federate that can interoperate with existing military simulations

Specific Technology that is being developed includes

Crowd conceptual models

Crowd federate that interacts with JSAF and OneSAF

Behavioral moderators for crowds

Users and Sponsors

Air Force Research Lab

Defense Modeling and Simulation Office

Joint Forces Command

Joint Non-Lethal Weapons Directorate

Army Maneuver Support Battlelab



Crowd Federate Psychological Foundation



- **Motivation**
 - Understand crowd behavior in military scenarios
 - Provide psychological basis for cognitive model
- **Methods**
 - Interviews and surveys
 - Behavior coding from crowd event video
 - Observe military crowd control training
 - Literature review
- **Status**
 - Project specific information gained
 - More study needed to provide firm basis

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The Motivation of the effort was to:

- Understand crowd behavior in military scenarios
- Provide psychological basis for cognitive model

Methods that were employed include

- Interviews and surveys
- Behavior coding from crowd event video
- Observe military crowd control training
- Literature review

Status

- Project specific information gained
- More study needed to provide firm basis

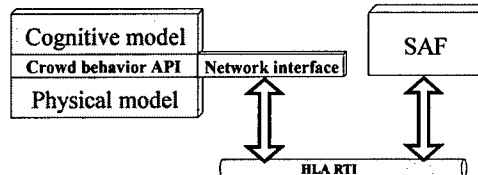


Crowd Federate Architecture



- **Modular architecture**

- Cognitive model
- Crowd behavior API
- Physical model
- Network interface



- **Software**

- Programmed in C++
- Uses some commercial software components

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A key product of the effort was a modular architecture that allows different models to be incorporated into a simulation

The software was programmed in C++



Crowd Federate

Crowd Parameters



- **Mood**
- **Size**
- **Propensity for violence**
- **Demographics**
- **Leadership structure**
- **Presence of Local Police Force**
- **Ability to negotiate**
- **Terrain**

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Some of the parameters that were modeled include:

Mood

Size

Propensity for violence

Demographics

Leadership structure

Presence of Local Police Force

Ability to negotiate

Terrain



Crowd Federate Implementation Tables



- **Maintain flexibility**
- **3 Tables for configuration**
 - Crowd Parameter x Crowd Parameter
 - Stimuli x Aggression Level
 - Aggression Level x Behavior
- **Certain combinations of factors will result in an increase or decrease of the crowds aggression level**
- **Configuration tables can be representative of differing cultures or population groups**

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The behavior is controlled through implementation tables, of which there are three:

3 Tables for configuration

Crowd Parameter x Crowd Parameter

Stimuli x Aggression Level

Aggression Level x Behavior

Certain combinations of factors will result in an increase or decrease of the crowds aggression level

Configuration tables can be representative of differing cultures or population groups



Crowd Federate

Crowd Parameter x Crowd Parameter



	Terrain. Steep	Terrain. Flat	CrowdSize. Small	CrowdSize. Med	CrowdSize. Big	Mood. Neutral	Mood. Avoidance	Mood. ...
Terrain. Steep								
Terrain. Flat								
CrowdSize. Small	-1	1						
CrowdSize. Med	-1	1						
CrowdSize. Big	-1	1						
Mood. Neutral	0	0	0	0	0			
Mood. Avoidance	-1	-1	-1	-1	-1			
Mood. Curious	-1	1	-1	-1	-1			
Mood. Aggressive Posture	1	1	1	1	1			
Mood. Aggressive Non-Lethal	1	1	1	1	1			
Mood. Aggressive Lethal	1	1	1	1	1			

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Here is the first table.



Crowd Federate Stimuli x Aggression Level



CROWD MEMBER TYPE	STIMULUS	Neutral	Avoidance	Curious	Low Aggressive	Med Aggressive	High Aggressive	Non-Lethal Less Violent	Non-Lethal More Violent	Lethal Action
Bystander	See Control For	0	0	0	0	0	0	0	0	0
	See friend (Byst)	0	0	0	0	0	0	0	0	0
	See Agitator	0	0	0	0	0	0	0	0	0
	See Protester	0	0	0	0	0	0	0	0	0
	See Casual	0	0	0	0	0	0	0	0	0
	See burning tire	-1	-1	-1	-1	-1	-1	-1	-1	-1
Casual	Hear gunfire	-1	-1	-1	-1	-1	-1	-1	-1	-1
	See Control For	-1	-1	-1	-1	1	1	1	1	1
	See friend (Casu)	0	-1	0	1	1	1	1	1	1
	See Agitator	0	-1	1	1	1	1	1	1	1
	See Protester	0	-1	1	1	1	1	1	1	1
	See Bystander	0	-1	0	1	1	1	1	1	1
Protestor	See burning tire	-1	-1	0	-1	1	1	1	1	1
	Hear gunfire	-1	-1	0	-1	1	1	1	1	1
	See Control For	-1	-1	-1	-1	1	1	1	1	1
	See friend (Prote)	-1	-1	1	1	1	1	1	1	1
	See Agitator	1	1	1	1	1	1	1	1	1
	See Casual	1	1	1	1	1	1	1	1	1
Agitator	See Bystander	0	0	0	0	0	0	0	0	0
	See burning tire	-1	-1	1	-1	1	1	1	1	1
	Hear gunfire	-1	-1	1	-1	1	1	1	1	1
	See Control For	1	1	1	1	1	1	1	1	1
	See friend (Agite)	1	1	1	1	1	1	1	1	1
	See Protester	1	1	1	1	1	1	1	1	1
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	See Bystander	1	1	1	1	1	1	1	1	1
	See burning tire	1	1	1	1	1	1	1	1	1
	Hear gunfire	1	1	1	1	1	1	1	1	1

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Table two.



Crowd Federate Aggression Level x Behavior (1 of 2)



Aggression Level	Behavior	Agitator	Protestor	Casual	Bystander
Avoidance	Fleeing from	20	20	25	27
	Crowd retreating	20	17	20	22
	Hiding	10	25	10	0
	Scattering	30	25	20	22
	Dispersing	30	18	25	29
Neutral	Standing around individually	40	60	40	50
	Observers not participating	60	40	60	50
Curious	Hanging out/watching	0	20	20	40
	Climbing elevated structures	0	40	20	10
	Wandering	0	20	40	10
	Staring at	0	20	20	40
LowAggressive	Flag waving	20	30	40	0
	Standing on elevated structure	20	30	40	0
	Seeking to	40	30	20	0
	Carrying weapon on shoulder	20	10	0	0
MedAggressive	Chanting	25	30	36	0
	Waving signs and banners	18	17	23	0
	Seeking to	13	12	12	0
	Overturning dumpsters	13	12	12	0
	Carrying weapon in-hand	18	12	0	0
	Marching	13	17	17	0

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Table three.



Crowd Federate Aggression Level x Behavior (2 of 2)



Aggression Level	Behavior	Agitator	Protestor	Casual	Bystander
HighAggressive	Cursing/yelling	15	16	17	0
	Obscene hand gestures	15	16	17	0
	Swarm to	15	15	15	0
	Looting	15	16	17	0
	Taunting	15	16	17	0
	Brandishing weapon	10	5	0	0
	Picking up projectiles	15	16	17	0
NonLethalLessViolent	Pushing	27	28	30	0
	Punching	27	28	30	0
	Burning objects	19	16	12	0
	Throwing objects	27	28	28	0
NonLethalMoreViolent	Throwing pepper gas cans	30	40	15	0
	Gang beating (fighting)	25	25	35	0
	Looting	25	25	35	0
	Shooting in air	20	10	15	0
LethalAction	Shooting at	40	33	0	0
	Throwing Molotov cocktail	14	15	0	0
	Throwing Grenade	18	22	0	0
	Shooting Technicos gun-mounted pickups	10	10	0	0
	RPG	18	20	0	0

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This table depicts some of the interactions between the various factors.



Crowd Federate

Army Maneuver Support Battlelab



- **Maneuver Enhancement Brigade Study 1 (Jun 05)**
 - Establish, Secure & Maintain Ground LOCs
 - OneSAF OTB used for core synthetic environment
 - Network Communications via DIS
 - MP personnel used as “pucksters” to control Army and OpFor
- **Crowd Federate Participation**
 - Communications achieved using JSAF HLA/DIS gateway
 - Provided key capabilities previously unavailable
 - First experience very positive, future collaboration is underway
 - AMSBL is now an advocate of the Crowd Federate

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The crowd federate has been demonstrated at the Army Maneuver Support Battle Lab



Crowd Federate Joint Forces Command



- **Multinational Experiment 4 (MNE 4)**
 - Refine and assess processes, organizations and technology to support Coalition and NATO Response Force with regards to EBO
 - Participants: Australia, Canada, Finland, France, Germany, Sweden, United Kingdom, NATO
 - Execution: 20 Feb – 17 Mar 06
- **Crowd Federate Participation**
 - Selected to play complementary role to SEAS (Synthetic Environment for Analysis and Simulation)
 - SEAS will monitor and control overall population
 - Crowd Federate will control “temporal” crowds created by SEAS
 - Communications over HLA

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There are plans to incorporate the crowd federate into a JFCOM exercise. In this exercise it will interact with another simulation.



Crowd Federate Summary



- **Successes**
 - Movement from demonstration to participation
 - Initial transition underway
 - Additional support for the AMBSL planned with FY05 funds
 - JFCOM is bringing the Crowd Federate into the ATT
 - JFCOM will use the Crowd Federate in upcoming NATO experiment
- **More work to be done**
 - Crowd/group & Individual level parameter understanding & validation
 - Psychological model refinement



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In summary...

Movement from demonstration to participation

Initial transition underway

Additional support for the AMBSL planned with FY05 funds

JFCOM is bringing the Crowd Federate into the ATT

JFCOM will use the Crowd Federate in upcoming NATO experiment

More work to be done

Crowd/group & Individual level parameter understanding & validation

Psychological model refinement



Rules of Engagement Evaluation Environment (ROE3)



- **Prime Contractor: Agent Oriented Software**

- **Project Definition**

- Create tools for investigating the employment and effects of Rules of Engagement (ROE)

- **Specific Technology**

- Human behavior modeling environment for modeling ROEs
- Framework and software tools for defining ROEs, tactics, behavior models and moderators
- Cognitive architecture that incorporates behavior moderators

- **Users and Sponsors**

- Air Force Research Lab
- Defense Modeling and Simulation Office



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Project Definition

Create tools for investigating the employment and effects of Rules of Engagement (ROE)

Specific Technology

Human behavior modeling environment for modeling ROEs
Framework and software tools for defining ROEs, tactics, behavior models and moderators
Cognitive architecture that incorporates behavior moderators

Users and Sponsors

Air Force Research Lab
Defense Modeling and Simulation Office



Rules of Engagement Evaluation Environment (ROE3)



PRODUCT:

- Human behavior modeling environment for modeling ROEs
- Framework and software tools for defining ROEs, tactics, behavior models and moderators
- Cognitive architecture that allows the invariant properties of human cognition to be configured across behavior models

IMPACT:

- ROEs can be systematically evaluated for effectiveness, clarity, unforeseen implications, and reliability
- Standardization of ROE formalization, thus reducing the cost and time to evaluate changes to ROEs

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PRODUCT:

Human behavior modeling environment for modeling ROEs

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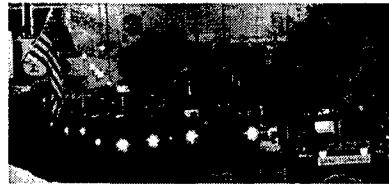


Rules of Engagement Evaluation Environment (ROE3)



- **Accomplishments**

- OneSAF OTB2 selected and obtained for simulation environment
- Convoy roadblock scenario with variations developed from SME and ROE Handbook
- Specification Document submitted by contractors (AOS)
- Initial integration between cognitive architecture (Co-Jack) and simulation environment (OneSAF) conducted
- Summary: Solid technical groundwork established and core developmental work is underway



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Accomplishments

OneSAF OTB2 selected and obtained for simulation environment

Convoy roadblock scenario with variations developed from SME and ROE Handbook

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Summary: Solid technical groundwork established and core developmental work is underway



Rules of Engagement Evaluation Environment (ROE3)



- **Future Developments**
 - Further define possible ROE3 uses:
 - ROE framework for DARWARS Ambush! trainer
 - ROE evaluation and demonstration tool for theater commanders
 - ROE framework for Fixed-Site Facility Defense Testbed
 - Continue to coordinate with JFCOM and JNLWD to develop user needs and feedback
- **Proof of Concept demonstration goals (Q3 FY05)**
 - Show the feasibility of modeling ROE in a simulation environment
 - Affect realistic/expected change in scenario resolution through the implementation of ROE
 - Secondary goal: demonstrate impact of behavior moderators on ROE and outcome
 - Generate support for implementation effort

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Potential future developments include:

Further define possible ROE3 uses:

ROE framework for DARWARS Ambush! trainer

ROE evaluation and demonstration tool for theater commanders

ROE framework for Fixed-Site Facility Defense Testbed

Continue to coordinate with JFCOM and JNLWD to develop user needs and feedback

Proof of Concept demonstration goals (Q3 FY05)

Show the feasibility of modeling ROE in a simulation environment

Affect realistic/expected change in scenario resolution through the implementation of ROE

Secondary goal: demonstrate impact of behavior moderators on ROE and outcome

Generate support for implementation effort



Rules of Engagement Evaluation Environment (ROE3)



- **Possible implementation actions**
 - **Provide UI control to allow users to test, evaluate, and demonstrate different ROE under various circumstances**
 - **ROE – Provide sets of ROE and a ROE construction tool**
 - **Scenario – Select location and event**
 - **Personnel – Friendly and opposition forces**
 - **Develop knowledge base and library of locations, ROE sets, and scenarios**



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Possible implementation actions

Provide UI control to allow users to test, evaluate, and demonstrate different ROE under various circumstances

ROE – Provide sets of ROE and a ROE construction tool

Scenario – Select location and event

Personnel – Friendly and opposition forces

Develop knowledge base and library of locations, ROE sets, and scenarios



Non-Lethal Weapon Models



- **Prime Contractor**
 - Micro Analysis & Design
- **Project Definition**
 - Develop Non-Lethal Weapons libraries for use in JSAF and OneSAF
- **Specific Technology**
 - Non-Lethal Weapon libraries in JSAF and OneSAF
- **Users and Sponsors**
 - Air Force Research Lab
 - Defense Modeling and Simulation Office
 - Joint Non-Lethal Weapons Directorate
 - Crowd Federate and ROE3



Micro Analysis & Design

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Another completed effort addressed the development of models of non-lethal weapons. Specifically, model libraries were created for JSAF and OneSAF.



Non-Lethal Weapons Models



- **Issues Dealt With**

- NLW related deficiencies in SAF
- Data to support Control Force behaviors

- **NLW Libraries**

- M203 (Grenade launcher)



- Smoke (yellow, white, red)
- Tear gas (CS)
- Fragmentary grenade
- Sponge round
- Crowd dispersal cartridge
- Rubber balls

- M16, M4 (Rifle)



- Metal bullets
- Rubber bullets
- Rubber balls encased

- M9 (Pistol)



- Metal bullets

- ADS

- Energy



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Model libraries include:

M203 (Grenade launcher)

Smoke (yellow, white, red)

Tear gas (CS)

Fragmentary grenade

Sponge round

Crowd dispersal cartridge

Rubber balls



Culture and Personality Testbed Overview



- **Prime Contractor: BBN Technologies**
- **Project Definition**
 - Develop research testbed using commercial game technology, Neverwinter Nights TM, to quantify the role of personality and cultural factors in military operations.
- **Specific Technology**
 - Algorithms and other techniques to represent socio-cultural knowledge
 - Quantitative data on cultural differences in military operations
 - C2 system analysis tools and methods
- **Users and Sponsors**
 - Air Force Research Lab
 - Army Research Lab
 - Defense Modeling and Simulation Office
 - NATO



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The Culture and Personality has completed the initial testbed.

Funding received for FY05 and FY06 to further refine the testbed and conduct experiments.

Initial BBN testing will compare Americans and Chinese (Boston area students)

The testbed is receiving a range of interest, test cases planned for NATO and Korea, also several graduate study programs are interested



Culture and Personality Testbed Problem Statement



- **Problem:** Military operations are increasingly multinational involving partner nations with diverse cultures
 - Wing Commander & Group Captain
 - Numbers, commas & decimals: 2.000 = ?
- **Military requires a better understanding of coalition partners for smoother operations**
- **Solution:** Increase militarily relevant research on culture and personality
 - NATO HFM ET 049: Coalition team work
 - NATO HFM ET 056: Cross-cultural perspective on military culture

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The problem we are addressing is:

Problem: Military operations are increasingly multinational involving partner nations with diverse cultures

Wing Commander & Group Captain

Numbers, commas & decimals: 2.000 = ?

Military requires a better understanding of coalition partners for smoother operations



Culture and Personality Testbed Vision



- **Vision:** Develop a testbed for culture & personality research based on a commercial game
- **Testbed Advantages**
 - Action/behavior based rather than hypothetical situations or self-reports
 - New paradigm for culture research!
 - Immersive environment:
 - True self can emerge
 - Replicability
 - Easier data collection
 - Decouple researcher & subject
 - Potentially larger subject pool available



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Our goal is to **Develop a testbed for culture & personality research based on a commercial game**

The advantages are:

Action/behavior based rather than hypothetical situations or self-reports

New paradigm for culture research!

Immersive environment:

True self can emerge

Replicability

Easier data collection

Decouple researcher & subject

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Culture and Personality Testbed

Testbed Features



- **Multi-player format**
- **Reasonable military situation portrayal**
- **Versatility through authorable scenarios**
- **Hooks to facilitate entity control by Human Behavior Model's (HBMs)**
- **Teammates/opponents playable by humans & HBMs**
- **Automated data capture**
- **Multiple mechanisms for data collection:**
 - **In-game behaviors as well as out-of-game surveys**

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Key features include:

Multi-player format

Reasonable military situation portrayal

Versatility through authorable scenarios

Hooks to facilitate entity control by Human Behavior Model's (HBMs)

Teammates/opponents playable by humans & HBMs

Automated data capture

Multiple mechanisms for data collection:

In-game behaviors as well as out-of-game surveys



Culture and Personality Testbed Methods for Data Collection



- **In-game behaviors**
- **In-game probes** (integrated into game narrative or gameplay)
 - questionnaires in guise of in-game conversations
 - write a memo
 - etc
- **Out-of-game probes**
 - occurs during the game, but not disguised as part of the game
- **Pre- and post-game evaluation**

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Date we can collect include:

In-game behaviors

In-game probes (integrated into game narrative or gameplay)

questionnaires in guise of in-game conversations

write a memo

etc

Out-of-game probes

occurs during the game, but not disguised as part of the game

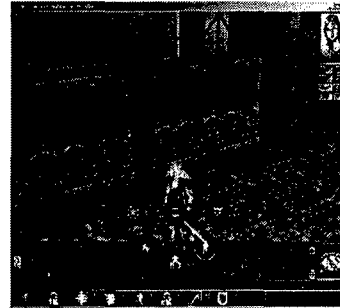
Pre- and post-game evaluation



Culture and Personality Testbed Decision Quality



- Scenario design determines which choices are correct & defines how much information will be available to players to guide choices
- Types of Decisions
 - Shall I attack or negotiate?
 - Which way will I go?
 - Who should I talk to?
 - Who do I believe?
 - What equipment will I use?
 - Should I expend a resource now or save it for later?



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The types of decisions the players have to make include:

Shall I attack or negotiate?

Which way will I go?

Who should I talk to?

Who do I believe?

What equipment will I use?

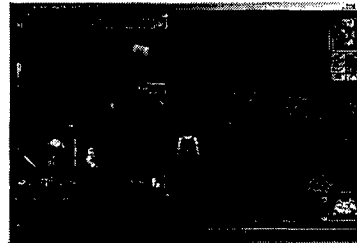
Should I expend a resource now or save it for later?



Culture and Personality Testbed Task Effectiveness



- NwN has many recurring tactical situations which provide rich data potentially useful for measuring task effectiveness
- Basic recurring tasks
 - Combat
 - Negotiation
 - Trap avoidance
 - Resource gathering
 - Exploration
- Other tasks could specifically be constructed for an experiment
 - Efficiency in monitoring AI participants, team members
 - Strategies chosen for team exploration



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NwN has many recurring tactical situations which provide rich data potentially useful for measuring task effectiveness

Basic recurring tasks

Combat

Negotiation

Trap avoidance

Resource gathering

Exploration

Other tasks could specifically be constructed for an experiment

Efficiency in monitoring AI participants, team members

Strategies chosen for team exploration



Culture and Personality Testbed

Time Pressure / Urgency



- **Place explicit time limits on decisions**
 - “No decision” becomes a decision after a certain point
- **Impose time limits for goals to be achieved**
- **Write scenarios so that time urgency immerses from the scenario**
 - E.g., the castle is falling apart so we need to leave soon
 - This may provoke more naturalistic reactions than artificial deadlines
 - This type of situation requires an immersive environment that works well in NwN, but not in a custom testbed solution

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Place explicit time limits on decisions

“No decision” becomes a decision after a certain point

Impose time limits for goals to be achieved

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This may provoke more naturalistic reactions than artificial deadlines

This type of situation requires an immersive environment that works well in NwN, but not in a custom testbed solution

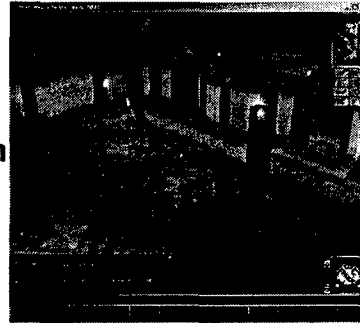


Culture and Personality Testbed

How to Measure Decision Making Strategies



- **Set up scenarios with options for**
 - Spending time gathering information
 - Spend time planning
 - Jumping directly into the situation
- **Monitor actions, individual & team**
 - Negotiation, exploration, combat,
 - Resource gathering, etc.
- **Monitor communication**
 - How much, who, about, etc
- **Scenarios can be fairly linear or very open & parallel allowing extensive experimenter control of degree of flexibility given to participants.**



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The way to measure decision-making is to

Set up scenarios with options for

Spending time gathering information

Spend time planning

Jumping directly into the situation

Monitor actions, individual & team

Negotiation, exploration, combat,

Resource gathering, etc.

Monitor communication

How much, who, about, etc

Scenarios can be fairly linear or very open & parallel allowing extensive experimenter control of degree of flexibility given to participants.

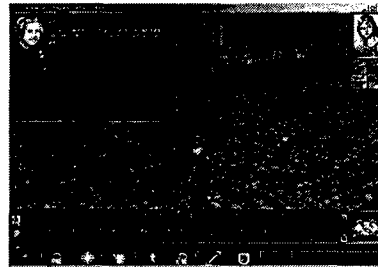


Culture and Personality Testbed

How to Measure Communication Patterns



- Communication mechanisms provided in game
- NwN virtual world constrains communication: only avatars in same virtual room can communicate
- Communication difficulty can be manipulated using these constraints



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Communication mechanisms provided in game

NwN virtual world constrains communication: only avatars in same virtual room can communicate

Communication difficulty can be manipulated using these constraints



Culture and Personality Testbed

How to Measure Situation Assessment



- **Can interrupt gameplay to assess participant's situation awareness**
 - Goals, current actions, threats, beliefs, etc
- **Can assess through nonplayer avatars**
 - Which may provide a more ecologically valid method of assessment

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Situation assessment can be measured by

Can interrupt gameplay to assess participant's situation awareness

Goals, current actions, threats, beliefs, etc

Can assess through nonplayer avatars

Which may provide a more ecologically valid method of assessment



Culture and Personality Testbed Initial Use of Testbed



NATO Sponsors

- Supreme Allied Command Transformation Headquarters (HQ SACT): Concept Development & Experimentation (CD&E) project “*Leader and Team Adaptability in Multinational Coalitions: Cultural Diversity in Cognition and Teamwork*”
- Research and Technology Organization (RTO) Human Factors & Medicine Exploratory Team 49 (HFM ET-049) project “*Adaptability in Coalition Teamwork*”

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International Research Team

•**FOCUS:** Improving team adaptability in multi-cultural military staff environments

•**EFFORT:**

- Establish national & NATO testbeds
- Identify system design requirements for collaborative tools, decision aids, & training
- Develop methods for experimentation
- Develop conceptual model of cultural adaptability for military operations

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Sponsors include:



Work Completed in FY04



- **Improved fidelity and accuracy of behavior models used in Joint Warfare Simulation (JWARS)**
 - **Commander Behavior Modeling for Command and Control (CBMC2) created more realistic decision models for three levels of command in JWARS (Incorporated into JWARS 1.6)**
- **Provided composability tools to OneSAF program office**
 - **Developed ontologies for describing primitive behavior metadata and composite behaviors**
 - **Demonstrated software tool that shows how composite behaviors can be developed in the future**

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In FY04 we

Improved fidelity and accuracy of behavior models used in Joint Warfare Simulation (JWARS)

Commander Behavior Modeling for Command and Control (CBMC2) created more realistic decision models for three levels of command in JWARS (Incorporated into JWARS 1.6)



The Future



- **DMSO Human Performance program is ending**
- **DMSO will focus on standards development**
- **Plan to transition existing programs to JFCOM and Service laboratories**

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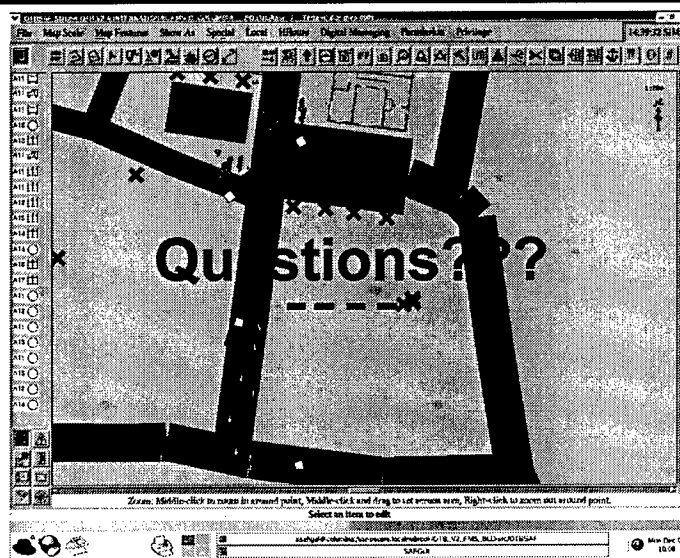
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DMSO Human Performance program is ending

DMSO will focus on standards development

Plan to transition existing programs to JFCOM and Service laboratories



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